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REFLECTIONS ON THE SIGNAL CORPS:
THE POWER OF PARADIGMS
IN AGES OF UNCERTAINTY

by

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ABSTRACT

TITLE: Reflections On The Signal Corps: The Power Of Paradigms In Ages Of Uncertainty

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The advent of the Information Age is reshaping the battlefield just as the Industrial Age did in the early twentieth century. The telephone redefined the fire support paradigm, resulting in the expanded role of artillery in World War I. Today digital data networks are redefining how we synchronize maneuver on the battlefield. Information technology, expected to make a thousandfold advance over the next twenty years, is already making our current organizational structures, doctrines, hardware and software inadequate.

This paper draws upon an historical example to address not just the "why" but also "what are consequences when the Army fails to change its paradigm of warfare based on the character of warfare it faces?" This is accomplished by constructing converging lines of evidence that establish the similarities of the Signal Corps as it struggled to support the American Expeditionary Force during World War I to an early twenty-first century Signal Corps faced with supporting future military operations in a predominately information age. This paper argues that the reluctance of America and its Army to accommodate the shift in warfare paradigms during the first two decades of the twentieth century contributed to its unpreparedness in general, and that of the Signal Corps specifically, to face the character of warfare present in Europe. This is not how to respond to today's revolution in information, but it is consistent with how historically the Signal Corps is channeled toward an evolutionary rather than revolutionary approach to supporting the Army. Instead of being shaped by emerging technologies or being fashioned by revolutionary change, the

Signal Corps is again caught in the "chaos of peace" when it should be preparing to fight the nation's information wars. The Signal Corps is missing the lessons that history has already taught us. It is bowing to the winds of resistance by embracing the ad hoc modifications of the old paradigm and calling it revolutionary. Unfortunately, the Signal Corps has been there and done that before.

BIOGRAPHICAL SKETCH

Lieutenant Colonel Ronald W. Vandiver earned a Bachelor of Science degree from the University of Tennessee in 1995 and a Master of Military Arts and Science (MMAS) from the Command and General Staff College at Fort Leavenworth, Kansas in 1987. His military education includes the Signal Officer Basic and Advance courses, the Combined Arms Staff Service School (CAS3), the United States Army Command and General Staff School (CGSC) and the Air War College (AWC). During Operation Just Cause he served as J6, Deployable Joint Task Force, J3 Directorate, USSOUTHCOM. He served with the 11th Signal Brigade as Commander, 40th Signal Battalion during the period June 1992 - June 1994. During the period of August through October 1992 he commanded Task Force 11 in Kuwait (Operation Southern Watch) and from December 1992 through April 1994 supported Operations Restore Hope and Continue Hope in Somalia. As a veteran of three separate operations in an imminent danger environment he is convinced of the need to consider the past when operating in the future.

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REFLECTIONS ON THE SIGNAL CORPS: THE POWER OF PARADIGMS IN AGES OF UNCERTAINTY

SECTION I

THE POWER OF PARADIGMS IN AGES OF UNCERTAINTY

Introduction

The military is often accused of preparing to fight not the next but the last war. But perhaps a more accurate description of the Army's current approach to preparing for the next conflict is found in General (Ret.) John R. Galvin's article, "Uncomfortable Wars: Toward A New Paradigm." He argues that America's failure is not in preparing for the last war, but rather constructing a comfortable vision of future war.

This comfortable conceptualization defines a battlefield that fits "our plans, our assumptions, our hopes, and our preconceived ideas." It is fought on battlefields we know, with conflicts that are consistent with our understanding of strategy and tactics, and in a combat environment that is predictable and "fightable with the resources we have."¹

But the information age represents a whole new era for America's Army; a time characterized by profound change in the nature of warfare. Throughout the Department of Defense and the Department of the Army senior leaders are acknowledging the idea that emerging information technologies are ushering in a Revolution in Military Affairs (RMA).² With the acceptance of information warfare as a key element of combat power, a hosts of compelling arguments are being constructed to support a change in the Army's

operational paradigm. That shift is from an industrial revolution-based maneuver warfare to an information revolution-based knowledge warfare.

Advocates of this shift argue that waging and winning war in the information age demand new thinking and require leaders to be far-sighted. In the words of the Army's senior leadership, "Success in the information age will go to those who have the courage to challenge themselves, who constantly innovate, and who learn to adapt as they go."³ These leaders speak of an Army that will confront both challenges and opportunities as it transforms itself to the character of the information age. While acknowledging that a new paradigm is required to realize real benefits from the Revolution in Military Affairs, they appear hesitant to adopt one. Despite the sound arguments of many, like Andy Marshall, who seek to simulate thinking by considering the ambiguities and complexities presented by the Revolution in Military Affairs, America's Army remains intent to frame the RMA around our comfortable, confident visions of tomorrow's conflicts. These are visions that fit America's existing paradigm of warfare. A question that begs to be answered is "why?"

This paper draws upon historical example in addressing not just the "why" but also the question "what are consequences when the Army fails to change its paradigm of warfare based on the character of warfare it faces?" By constructing converging lines of evidence it establishes the similarities of the Signal Corps as it struggled to support the American Expeditionary Force during World War I to an early twenty-first century Signal Corps faced with supporting future military operations in a predominately information age.

This paper argues that the reluctance of America and its Army to accommodate the shift in warfare paradigms during the first two decades of the twentieth century contributed to its unpreparedness in general, and that of the Signal Corps specifically, to

face the character of warfare present in Europe. During the period 1900-1920 a combination of political, social and technological developments served to stimulate a worldwide change in the nature of warfare. However, the willingness of military institutions to accept that change also required an acceptance that it would bring instability and uncertainty.⁴

Consistent with the Army's model of comfortable war, civilian and military senior leaders became reluctant to respond to an emerging paradigm that redefined the dimensions of the conflicts that lay ahead. So it is today with America's military leaders. The political, economic and social pressures brought to bear upon the Army ultimately serve to reduce its versatility, adaptability and flexibility in responding to the nature of warfare it confronts. An America that embraced isolationism believed itself capable of distancing itself from the great war in Europe. This same America believes today it can make selective engagement work and fashion the battles it fights.

After establishing that the Signal Corps' current approach to changing to an information revolution-based warfare paradigm is flawed, this paper draws upon its pre-World War I predecessor as a case study. Three questions develop the argument that a change of the Army's dominant paradigm was appropriate before the Signal Corps' entrance into Europe. The first question is "Did technology provide previously unavailable battlefield capabilities with the potential to fundamentally change the nature of warfare?" Second, "Did the Signal Corps have people possessing both vision and practical military experience that could translate the opportunities that technology provided into a working strategy they would openly advocate?" And third, "Were there individuals with the authority to effect change that would take advantage of the new technology and reorient

the force on a new, more effective paradigm?" This paper will study the consequences of not changing its paradigm is examined by assessing the impact on the equipping, manning, training, and directing of the Signal Corps. Drawing from this historical example demonstrates the parallels that exist between yesterday and tomorrow. Social, technological and political revolutions served as the shapers to the transformation process that resulted in an industrial revolution-based maneuver warfare. These same influences are fashioning today's warfare into an information revolution-based knowledge warfare.

Paradigm Defined

A paradigm is much more than simply "an example or model" as defined in the *American Heritage Dictionary*. It encompasses a common set of beliefs shared by its subscribers. It is a model of reality that filters all the information received and becomes the basis for fundamental decision making.⁵ Thomas Kuhn describes a paradigm as "intrinsically circular." A paradigm is what the members of a community share, and, conversely, a community consists of men who share a paradigm.⁶ He informs us that paradigms provide not only the map but also some directions essential for map making.⁷ For the military community the paradigm is the basis of doctrine, strategy, tactics, techniques, force structure, and weapon systems. Since that is the case, questioning of the existing dominant paradigm is a simultaneously decision to challenge the viability of its outputs.

Kuhn states "The transition from a paradigm in crisis to a new one from which a new tradition . . . can emerge is far from a cumulative process, one achieved by an articulation or extension of the old paradigm. Rather it is a reconstruction of the field from new

fundamentals, a reconstruction that changes some of the field's most elementary theoretical generalizations as well as many of its paradigm's methods and applications.⁸ He concludes that when the transition is complete the community will have changed its view of the field, methods and goals. But paradigms once embraced by the military community are difficult to change.

If "reality" is changing at unprecedeted rates, but paradigms are slow to adapt the necessary conclusion is that the institution's model of reality is in a continuing state of obsolescence. But that is not easily seen by the community who established its legitimacy as the practitioners of the paradigm. Having intensely concentrated on gaining resources to establish its dominance, to change it requires perhaps more than what the community is capable of doing. As Kuhn states defenders of the status quo "will devise numerous articulations and *ad hoc* modifications" of the old paradigm.⁹ Yet, it is imperative the military community understand they court disaster if they fail to review the appropriateness of the current paradigm in light of the political, military and technological environment in which they are operating.¹⁰ But "changing paradigms by accretion of experience is at best a slow process."¹¹ But change it must.

A Paradigm in Embryo: Its Right To Life

Dana Cound argues that two ways paradigms are changed are by experience or the introduction of information, or by revelation or insight.¹² As the existing paradigm becomes increasingly blurred amidst the evidence of revolutionary change and no longer fits the problems it faces, the question then becomes how one gains that experience or insight. Baron de Antoine Henri Jomini asserted that examples from history make

everything clear and that this applies with more force to the art of war than to any other.¹³

David B. Hawke, a seasoned historian, concludes "in the studying of history, there can be clues and even limited answers, but mostly it teaches one how to think and consider all the variables."¹⁴ Tomorrow's hope then lies with those in the military community who will dare to lead the way from the old paradigm towards the new by viewing the past as they construct the future Army. Kuhn reminds us that "almost always the men who achieve these fundamental inventions of a new paradigm have been either very young or very new to the field."¹⁵ A new paradigm emerges first in the mind of one or two individuals who learn to see differently.

Correctly viewing history during a Revolution in Military Affairs results in the kind of phenomena Kuhn writes about when the community sees "new and different things when looking with familiar instruments in places they have looked before."¹⁶ Yet, it appears the Signal Corps possesses a vision ruled by the old paradigm and is destined to traveled a path already traveled by its World War I predecessor. In 1992 the United States Army Signal Center at Fort Gordon, Georgia, published a document titled *Signal 2000* that outlined the role of the Signal Corps and its transition into the twenty-first century.¹⁷ Projecting the impact of emerging information and communication technologies, it acknowledged the necessity to develop, field and employ an information force capable of supporting any mission in the joint, combined, or allied arena. At first glance it appears the Signal Corps recognized that without each element of the combat development process¹⁸ undergoing a shift towards the information revolution-based knowledge warfare paradigm, the Army would not be able to achieve the full potential of its Revolution in Military Affairs. Yet, close examination of the document's language reflects strong ties to

the past that simply attempts to adapt current practices and concepts within a limited, comfortable focus. Ultimately it is just a restricted approach to overlaying new technology to "Second Wave" doctrines of maneuver warfare. At best it is an updated version of the existing paradigm.

This is not how to respond to today's revolution in information, but it is consistent with how historically the Signal Corps is channeled toward an evolutionary rather than revolutionary approach to supporting the Army. Instead of being shaped by emerging technologies or being fashioned by revolutionary change, the Signal Corps is again caught in the "chaos of peace" when it should be preparing to fight the nation's information wars. The Signal Corps is missing the lessons that history has already taught us. It is bowing to the winds of resistance by embracing the ad hoc modifications of the old paradigm and calling it revolutionary. Unfortunately, the Signal Corps has been there and done that before.

The advent of the Information Age is reshaping the battlefield just as the Industrial Age did in the early twentieth century. The telephone redefined the fire support paradigm, resulting in the expanded role of artillery in World War I. Today digital data networks are redefining how we synchronize maneuver on the battlefield. Information technology, expected to make a thousandfold advance over the next twenty years, is already making the current organizational structures, doctrines, hardware and software inadequate.

Field manual 21-1 defines signal support to the future warfighter as greater than combat communications and involving more than the Signal Corps. Although the lines of responsibility regarding the providers of communication and information services to the Army warfighter are sometimes blurred, the Signal Corps' mission is nevertheless clear.

Signal support is "the collective, integrated and synchronized use of information systems, services and resources".¹⁹ Its mission is to provide rapid and reliable signal support for the command and control of the Army's combat forces. The Signal Corps needs to comprehend the full extent of how information technologies will influence war and the management of forces. The key is to unleash a thought process within the Signal Corps' leadership that considers how to posture the Signal Corps for the next war.

SECTION II

A CALL TO TRANSITION

Changing The Paradigm

Evolutionary changes are made within the framework of the existing paradigm embraced by the Army. But, revolutionary changes require a new paradigm. Richard Dunn suggests that three conditions must exist for a changing of paradigm to occur. First, previously unavailable battlefield capabilities introduced in the form of technological developments that fundamentally change warfare's nature occur. Next, people possessing both vision and practical military experience translate the opportunities that technology provides into a working strategy they openly advocate. Finally, decisionmakers force time sensitive changes in order to gain maximum benefits of the emerging technology and reorient the force on the new, more effective paradigm.²⁰

A review of the period 1905 - 1918 offers a classic example of an organization, the United States Army Signal Corps, emerging during the infancy of a profound revolution in military affairs. In responding to an unprecedented rate of technological development, the opportunity to shift to a new paradigm existed. An adaptation of the framework outlined by Dunn offers the opportunity to consider why it did not, or could not, change.

Did technology provide previously unavailable battlefield capabilities that possessed the potential to fundamentally change the nature of warfare?

The old methods employed in ground signaling fulfilled the requirements of a turn of the century Army engaged in small-scale maneuvers or patrolling the Mexican Border.

Quenched-spark sets transported by pack or wagon introduced radio into field maneuvers.²¹ However, buzzers, messengers and visual signaling provided the basic command and control communications to the Army. In fact, only visual signaling counted for much in the field. Although the field artillery possessed telephones for fire control from 1905, it used flags as its primary means of communications. The telephone gave no promise of sturdy tactical military use in the immediate future and telegraph trains, increased in size to nine wagons, were still rear-echelon communications. Although Lee de Forest patented the three-electron vacuum tube in 1906, and its amplifying circuit in 1907, the Signal Corps did not pursue its potential for vast improvements to existing portable and fixed radio sets. Vacuum tubes were used for receiving and amplifying purposes, but not considered for transmission uses. In fact, production of the vacuum tube in America did not begin outside commercial laboratories until after U.S. entry into World War I.²²

The lines of communication provided by the Signal Corps during the Punitive Expedition consisted only of telegraph service along the Line of Communication, supplemented by radio as the alternate means. In order to fulfill these requirements, the Signal Corps assembled several different field stations from among units already in operation along the border. No combat field wire lines were laid nor were any messages transmitted by visual signaling. During this period aeroplanes participated in active service for the first time in the history of the United States Army.²³

In 1917 BG C. McK. Saltzman, Acting Chief Signal Officer, stated that the Signal Corps supported the Punitive Expedition with "some difficulty."²⁴ MG John J. Pershing in his report more clearly defined the difficulty encountered. The Signal Corps was initially

without field wire to support the movement of troops between Columbus, New Mexico and Mexico. Radio communications proved unsatisfactory. The radios used had been in continuous service without opportunity for rebuilding prior to commitment, and repair part availability was nonexistent for German manufactured sets. In addition there was a lack of appreciation for the limitations of the pack radio sets. Eight unserviceable aeroplanes constituted the equipment authorization for the Punitive Expedition's squadron. The squadron's organization itself was "very imperfect and incomplete."²⁵

Recognizing a need for improvements, Signal Corps appropriations' and personnel authorizations measurably increased after several months. Specifically, appropriations for the Air service increased tenfold and additional increases in the Reserve Corps' personnel strengths occurred. The War Department gave the Corps authority to proceed with the organization of units and the purchase of equipment to meet *existing* needs.²⁶ Meanwhile America's involvement in the European war seemed more certain everyday.

The Signal Corps had not remained inactive during the period 1914-1916, but its definition of tactical communication requirements had not shifted to accommodate the Revolution in Military Affairs happening before its eyes.²⁷ This translated into a Signal Corps unprepared to support the character of warfare it would face in France. Providing and maintaining communication support in this war became a process of improvisation. Survival on the battlefield mandated the Germans, French and British adopt communication means previously dismissed. Radio, considered an unreliable means of transmitting information on the battlefield in 1914, evolved into an integral part of influencing the control of battle during movement by 1917. Wire communications, specifically the telephone, now replaced visual signaling devices and methods.

By the time America entered the war communications equipment developed by the French and British fulfilled the requirements of their armies in the trenches. Although not the primary means of transmitting information, the radio received much attention by all the belligerents. Small tube radio sets with resulting maximum selectivity and power designed to operate at ranges mandated by close stationary warfare were now common items in their armies. Radios in the American Army were not of this type. America's Signal Corps focused its development on long-range radio work sets with a normal range of 250 miles overland and as much as 800 miles over water. In Circular No. 8, BG Scriven stated that the four types of radio in use or under construction by the Signal Corps were "quite equal to any elsewhere existing." That was true, but none of the four being developed were suitable for the trenches. The Signal Corps equipped itself, but not based on a paradigm of stationary warfare in the trenches.

The Signal Corps maintained a technical engineering staff responsible for the development and improvement of communication apparatus. However, modernization of the Signal Corps was not a peacetime priority. Without a foreign or military policy that considered intervention overseas, the Signal Corps based its modernization of equipment and organizational changes to support the Punitive Expedition. Unfortunately, the character of warfare existing in Mexico was completely opposite of that in Europe.

Thus these years embraced incremental change that did not challenge the status quo-technologically, organizationally, or doctrinally. They had the potential to fundamentally change the nature of warfare, but did anyone recognize the opportunities provided by these technological changes? Were their strong advocates for their adoption and adaptation to a new paradigm?

Did the Signal Corps have people possessing both vision and practical military experience that could translate the opportunities that technology provided into a working strategy they would openly advocate?

In subsequent years various signal officers developed proposals for future communication methods that could capitalize on emerging technologies. In 1909 Signal Corps Captain William Mitchell presented a "Lecture on Field Signal Communications" at the United States Army Infantry and Cavalry School. This lecture included proposed equipment and corresponding employment changes, and recommended the adoption of tactical communications equipment used by the German Army and other European countries.²⁸ Soon afterwards the Signal Corps adopted a German-made radio for use in the field, and experimented with communication devices from other countries. In 1915, when American involvement in World War I seemed to be increasingly likely, BG George Scriven, Chief Signal Officer, prepared Circular No. 8, *Service of Information*. He wrote that any officer about to assume command of an expeditionary force in a foreign country would not willingly lack information on the types of communications systems required to transmit information effectively and efficiently in the new theater. Therefore, he stated, the commander must trust the signal officer to determine what communications to establish and the type of signaling devices to use.

Conscious of the events abroad, BG Scriven addressed in broad terms the impact of electricity on the conduct and control of battle, and outlined the capabilities and functions of the services of information in the armies of foreign nations. Unfortunately, his information was sketchy. His use of the phrases "though not yet fully known in detail" and "not until long after the present war is ended will a full knowledge of these and other

marvelous developments be known," exposed a significant obstacle to the Signal Corps' ability to pursue a paradigm based on the European style of warfare. America was neutral, still at 'peace.' Thus, detailed information from any of the belligerents pertaining to technological developments was non-existent, or incomplete at best.²⁹ Men like Scriven and Mitchell possessed both the vision and experience to fashion a strategy that could take advantage of the opportunities technology could provide. But, they were not the ones with the authority to effect change.

**Were there individuals with the authority to effect change that would take
advantage of the new technology and reorient the force on a new, more
effective paradigm?**

Three categories of "authority" possessed the potential to effect the kind of fundamental change that could focus the Signal Corps towards a new, more effective paradigm. They were the nation (the national ethos), civilian leadership (Executive and Legislative branches) and senior military leadership. Each contributed to the shaping process of the Signal Corps that emerged to support the American Expeditionary Force in France. Whether the Signal Corps shifted toward a paradigm consistent with the nature of warfare existing in Europe depended upon the significant influence brought to bear from these different, but converging influences.

The National Ethos

The national ethos helped define the limits and establish the structural framework of the nation's military force. During this period it played the role of keeping the Army relatively small and influenced the dynamics of how citizen soldiers would participate in

military affairs. According to Edward M. Coffman's research, where the national ethos played a crucial role was in the debate between Regulars who advocated citizen-soldiers as part of the federal force and the National Guard who insisted the militia be under state control. The tradition of state rights prohibited anything more than a token reserve force for the federal army prior to World War One.

Indirectly this debate translated into reduced dollar investments to maintain and modernize a large standing Army. Coffman writes, "Soldiers in the first decades of the century observed the development of the truck, the airplane, the machine-gun and the evolution of high-trajectory field pieces, but they did not have to watch them too closely because they had little effect on most of the Army." The existence of a significant part of the economy dedicated to equipping its "peacetime" Army did not fit in well with the American military attitude of the day. In the 1921 words of Secretary of War John W. Weeks, "The American people are traditionally opposed to the maintaining of a large, standing Army."³⁰ Therefore, the national ethos was clearly a dominant factor in keeping the Army at a reduced level throughout the period of 1905-1916. Thus, to recognize a need to change the existing paradigm would have translated into the need for a larger force structure equipped differently at a resource cost that stood in opposition to the national ethos. That was diametrically opposed to the framework of a small standing Army of "professionals" whose responsibility was to train the citizen soldier in the operational art of war when it became necessary. Acceptance would force Congress and the President to choose between modernization and maintaining adequate force structure.

The Executive and Legislative Branches

In 1914 the conflict in Europe evoked the sympathy of many American leaders and a segment of the general public, but for most the war was too far removed from America to warrant attention. None of the warring powers seriously challenged America's position of neutrality, and the ability of any enemy forces to threaten American security from the other side of the world was considered remote.

The leaders of America believed that in the unlikely event America was confronted with a situation warranting a military response, such responses as were necessary would be established. T. Harry Williams in *The History of American Wars* states that this prevailing estimate was realistic up to a point. America's military forces in the defense were adequate against any conceivable attack, but could not have sustained an offensive operation against any major power. Compared to the 100,000 American troops authorized for the regular army, France had 1.5 million troops and Germany had 2 million available in 1914. Additionally command arrangements in the highest military level were inadequate for conducting a major war. Command personnel were quantitatively inadequate for exercising effective control of, or planning for, possible wars. The General Staff, as a result of the War Department bureaus' intervention, had been reduced by congressional legislation in 1912 to thirty-six personnel, a far cry from the hundreds manning the staffs of major European powers.³¹

The state of the military force structure caused little alarm among America's leaders until 1915. For the first time America recognized, based on the successes of Germany's submarine campaign, the possibility of a German victory. In 1916 President Wilson won on the platform, "He kept us out of war," but he soon had to consider whether or not the

nation was prepared to fight a major power. Late in 1915 the General Staff submitted to the War Department a study entitled "A Proper Military Policy for the United States," proposing a plan to defend America with a citizen army in keeping with America's tradition. This plan, modified by the President, resulted in the National Defense Act of 1916.³²

After the passage of this legislation the Wilson administration's preparation for America's defense proceeded without urgency. In fact, the president openly resisted efforts in planning for war. On one occasion when informed war plans were being devised by the General Staff, he went "white with passion" and stated that such exercises should stop. The military, now in isolation, attempted to develop a military strategy that was in concert with America's foreign policy. Excerpts from an address given to the New York Society of Military and Naval Officers of the World War on 5 December 1933 by Major General J. Harbord, Chairman of the Board, Radio Corporation of America, addressed the impact of not having a coordinated military policy and a focused civilian leadership in regards to maintaining a technological balance with other major powers.

With the inventive genius of our (U.S.) people the extent to which invention and manufacture are in this country preceded by research, and the capital available for investment in such things, it was to be expected that America would not lag in the adoption of the most modern devices for its national defense. The officers of our Army and Navy have always striven for the latest word in equipment and armament. Our Government . . . is, however, peculiarly susceptible to the influence of organized minorities. . . . The Great War, like all its predecessors, found us unprepared even in things where in a commercial sense we led the world.³³

Reflecting the will of people and consistent with the national ethos, neither the Executive or Legislative branches of the prewar years were willing to support a paradigm shift that would result in changing the national military strategy. Thus civilian leadership

gave the nation an Armed Forces not based on a revolutionary model but an affordable one consistent with the domestic and international environment as interpreted by the American public and consistent with the national ethos.

Senior Military Leadership

Were there military senior leaders with the authority to effect change that would take advantage of the new technology and reorient the force on a new, more effective paradigm? The historical record speaks for itself regarding General Pershing as the shaper of the American Expeditionary Force. After Pershing's exposure to the tactical techniques employed by the Allies, he directed his division commanders to "minimize their dependence on Allied instructors." So while the Allies concentrated on small unit training with emphasis on automatic weapons, mortars and grenades, Pershing focused his army on large unit assaults with primary emphasis on rifle fire and artillery support. "A student of warfare who appreciated the firepower of modern armies, Pershing knew the value of troop dispersion, fluid tactics, and punishing artillery support." He sought to make it work despite the lessons learned by the Allies in 1914 and 1915.³⁴ Embracing such a position created ambivalent doctrine that failed to provide a sound basis for training and subsequent combat performance.

The basic ambivalence focused on the fact that Pershing articulated a position based on open warfare, but "he and the War Department in practice prepared an Army whose fundamental capability lay in inflicting casualties on the Germans in a static, grinding war of attrition."³⁵ James Rainey in his article "The Questionable Training of the AEF in World War I," provides insight into why Pershing failed to acknowledge the reality that his

Army was in a war of attrition; why he refused to define "a tactical methodology in closer harmony with the nature of war as he saw it."³⁶ He states,

A partial answer may be that Pershing's hidebound insistence on preparing his Army for open warfare had something to do with the "amalgamation controversy," that political-military debate in which he strenuously fought off repeated Allied requests to employ AEF soldiers as individual fillers for their own depleted units. One of the arguments Pershing employed to keep these wolves at bay was his claim that the AEF must remain intact so as able to employ its unique tactical solution to the stalemate of the trenches. Having made such a case for open warfare, however, Pershing had boxed himself into the corner. To admit that he was wrong, and that the AEF would have to adopt some other tactical methodology such as attrition, would undercut his argument against amalgamation of US forces. He had to remain insistence that open warfare was the key to success, but in doing so he prevented himself from making an honest reassessment of the tactical problem, leaving his commanders without a sanctioned basis for teaching the attrition method they would in fact employ.³⁷

In order to shift toward a position consistent with European warfare, an "authority" whose influence would be decisive in gaining the approval of the paradigm would be singularly important. Pershing's insistence on shaping the America Expeditionary Force based on a model of open warfare blinded him from seeing the reality of the European battlefield. In a position to effect change he embraced that which was comfortable to his experience and his personal vision of the AEF's role in the Great War.

The Challenges of Building The Signal Corps based on the Wrong Paradigm

On 2 April 1917 President Wilson went before Congress and asked for a declaration of war. In his address he stated his intentions to raise and dispatch to Europe a large ground force. The government had finally announced a military strategy, but to organize and equip such a force as envisioned by President Wilson demanded an effort in scope and distance unlike any that had come before.³⁸ The Signal Corps had fulfilled its

responsibility in years past but now faced unprecedeted challenges. The expansion of the Signal Corps would mark a dividing point in its history. Its transition from a "band of individual experimenters" without the time to "solidify their experience and call it doctrine" to a organization that "took on a corporate existence of its own matched by corporate control" occurred practically overnight.³⁹ "In a race against the time-clock of pressing necessity" the Signal Corps in 1917 began its struggle to respond to the communications requirements of an America at war.⁴⁰

The challenge confronting the United States Army Signal Corps was to provide in the shortest time possible communications support extending from the training camps to the front-line trenches. Limitations in both equipment and manpower adversely influenced its ability to satisfy the task at hand. Compounding the situation was the fact that only a handful of qualified officers were available to plan the communications system and pursue the acquisition of the equipment immediately needed.⁴¹

When the first elements of the American Expeditionary Forces (AEF) arrived in France in the spring of 1917, they faced the reality of modern warfare based on a paradigm inconsistent with their own. Above all else this war had become an engineering operation in which every branch of scientific research was being used to bring about the defeat of Germany. In no branch of the Army was up-to-date technical knowledge more necessary than the Signal Corps, yet the opportunity to prepare for war during a time of peace had not been allowed.⁴² What little preparation had been made was based on a different war paradigm. Three years of intensive wartime development and experience had resulted in major improvements to the communications equipment of all the belligerents. To combat the enemy's achievements the AEF possessed limited tactical communications

resources which, though suited for operations such as might be expected by America, were not adapted to the conditions prevalent in this European War. The consequences of building America's Army Signal Corps on the foundation of the wrong paradigm adversely permeated its equipment, force structure, training focus and doctrine.

Equipping The Corps-A Technological Challenge

Much of the ground signaling equipment brought to Europe in 1917 by the Signal Corps was "wholly unsuitable for the character of warfare then existing."⁴³ As America's war involvement began the Signal Corps was equipped, without modification, exactly as it had been prior to 1914.⁴⁴ Three years of intensive wartime development and experience resulted in both evolutionary and revolutionary changes in communications equipment and their subsequent schemes of employment on the battlefield. As quickly as technological breakthroughs occurred warring countries adopted them and began to shift toward a new paradigm of warfare. The British Expeditionary Forces prior to the war depended on the telegraph, visual signaling techniques and messengers. The introduction of the telephone and the conditions of trench/stationary warfare brought about the virtual disappearance of visual communications and significantly changed the employment of other communications assets.⁴⁵

To meet the immediate needs of the AEF the Signal Corps like the other branches of service, adopted French equipment. Had this option not been available the communications mission for the AEF could not have been fulfilled. More than ever the Signal Corps recognized the need to establish laboratories that would develop equipment to satisfy future requirements. Unfortunately, it was too late to help the signal soldier of the Great War. A contributor to the problem was the difficulty of mobilizing America's industrial

base. The absence of a definitive schedule of requirements and a lack of knowledge regarding the capabilities and capacity of both American and foreign industry had its consequences. The armistice found the U.S. Army nearing the development of a series of radio sets especially designed to meet current requirements, but very little of this equipment found its way into the hands of American troops.⁴⁶ The Signal Corps entered the European theater at a disadvantage and was never able to overcome it.

Durant Terrett in his book, *The Signal Corps: The Emergency*, sums up the Signal Corps' technological development when he states:

The United States began and completed its role in the 1917-1918 war without reaching a development in either combat communications or combat aviation comparable to that of France or Great Britain. In both fields the nation's war experience was shorter, its appropriations smaller, and to a considerable degree its industry slow to start and its research too late to be felt.⁴⁷

Raising The Corps-An Organizational Challenge

Even if the Signal Corps had been equipped with the latest technology, a greater obstacle confronted it: the ability to furnish the trained personnel and units in the numbers required within the appropriate time limits. The Signal Corps was neither the biggest nor the oldest of the technical services. Just prior to the declaration of war against Germany the Signal Corps of the Regular Army consisted of 55 officers and 1,570 men. Of the 55 officers, 42 were on duty with Signal Corps organizations. Fully half of the enlisted personnel were in the Washington-Alaska Military Cable and Telegraph System, while the remainder were loosely organized into separate field and telegraph battalions. The National Guard, with a Signal Corps strength of 163 officers and 3,510 enlisted, was organized into ten field battalions and 16 separate companies, none of which were

telegraph companies. The Reserve Corps, which had been authorized in the National Defense Act, did not actually have personnel assigned to the 27 field battalions and 12 telegraph battalions authorized.⁴⁸ In order to meet its mission, the Signal Corps faced multiplying itself by thirty-five almost immediately.⁴⁹

But, "very little planning had been done before the beginning of the war for the procurement and training of technical personnel adequate for a major emergency."⁵⁰ It quickly became obvious to the Chief Signal Officer that the communications specialists required for the first year of the war could only be obtained by using Army personnel whose prior civilian occupation qualified them for service, or by enlisting or inducting civilians already trained to perform as specialists. Efforts were made to transfer qualified enlisted men from other Arms and services but with little success. Until the creation of the Committee on the Classification of Personnel on August 5, 1917, the Signal Corps had little influence over the assignment of technically qualified civilians to its service.⁵¹ This staffing difficulty created significant problems in the fielding of technicians needed to construct the backbone communications system in France scheduled for completion prior to the arrival of American combat troops in December 1917. The Signal Corps initial success in fielding its first battalion was due to the response of commercial telephone and telegraph companies who released qualified personnel for service, not prior planning and preparation. But training was not the only organizational issue. The tables of organization and equipment themselves were not in alignment with mission requirements.

The field battalion provided communications support to the ground forces; the telegraph battalion supported the rear zone of operations. Regulations provided for one battalion to each infantry and cavalry division. Distribution of signal troops was then

determined by the organization of the combat division. Upon entry into the war the division strength increased without a corresponding increase in the field battalion. A make-shift restructure increased its size and provided for reinforcements of communications personnel from the Infantry. "This organization was never entirely satisfactory. . . ."⁵² It simply did not have the manpower nor the equipment allowances required to support the elaborate systems of communications, including radio, mandated by the character of warfare existing in Europe.

In 1916 electrical means of communications were not available below brigade level in infantry divisions. The Field Artillery depended upon wire as their primary communications means and no electrical means for Artillery-Infantry liaison existed.⁵³ In contrast the British in 1916 authorized three types of wireless sets for forward communications and in 1917 reorganized to maximize their employment. As early as the summer of 1915 the British tested radio communications to link forward observation posts with heavy artillery. Alignments of organizational structures and equipment authorizations by combatants were prevalent during the period of 1914-1917.⁵⁴ In comparison, changes to the AEF Signal Corps based on the wartime experiences of the other combatants were insignificant until after 1917. This included the needed adaptations of U.S. doctrine to those of the major allies.

Directing the Corps in Battle-The Doctrinal Challenge

"The first months in France were spent in making studies of signaling methods as developed by the allied powers. . . ."⁵⁵ The Signal Corps quickly found that just as their equipment was unsuitable for the battlefield so was the doctrine that governed its employment. The campaigns on the eastern and western fronts in 1914 during "the mobile

period of the war" had influenced The Signal Corps development of signal communications in the tactical environment because it fit within the existing U.S. Army paradigm of warfare.⁵⁶ The 1914 doctrine specified signal communications within the infantry brigade by visual means and messengers. Wire and radio transmitted over long distances; wire being designated as the primary means. But when the conditions of stationary warfare brought about changes beginning in 1915, the Signal Corps remained anchored to the old paradigm.

General Pershing's insistence on training to perfect an open warfare doctrine that was at odds with the character of warfare existing on the Western Front intensified the Signal Corps' struggle in defining and publishing doctrine.⁵⁷ The Signal Corps' initial response to changing its doctrine was to delay the updating or creation of new doctrine. For example the French and British experienced success in using homing pigeons to carry important messages. Upon General Pershing's personal recommendation the War Department created the Pigeon Service in July 1917. Although the exploits of individual birds were extraordinary the following quotation explains why they weren't more effective:

The work of the pigeons in the World War can be considered as highly satisfactory when we take into account that fact that at that time no training literature nor any approved doctrine governing their tactical employment.⁵⁸

Unfortunately the lack of doctrine didn't just affect pigeons but also troops engaged in battle. In fog and bad weather, in the dust and smoke of heavy shelling, visual signaling was impossible. The heavy bombardment resulted in the burying of cables in trenches which, though at first shallow, gained in depth until safety for their lines was found. They recognized that even the most flexible and varied communications systems could not

ensure the transmission of messages. For that reason their doctrine provided for alternate means and emphasized its use. "Wireless, at first looked down on, and justly so, because of its availability for the enemy as well as friendly troops, through the use of adequate cipher and codes (and the intelligent use of it), gained rapid favor."⁵⁹ But, the lack of doctrine contributed to the hesitation of American commanders to employ it. In the St. Mihiel offensive it was common to receive the following message from a brigade commander by radio: "I am absolutely out of all communications," and doctrinally he was correct.⁶⁰

A reprint of a British pamphlet by the America's War Plans Division in May 1918 entitled *Inter-Communication in the Field*, eventually gave the Signal Corps a doctrinal model that employed the agencies of signaling described above. The pamphlet outlined the requirements for a communications system: reliability, speed in transmission, simplicity, and the ability to support a changing tactical situation without confusion and using minimum resources.⁶¹ The 1918 doctrine prescribed installation of "axis of liaison" by the next higher command down to and including battalions. Means of communications included panels and pyrotechnics for air-ground liaison, telephone, ground telegraphy, radio, runners and pigeons. Unfortunately, its adaptation was based on Pershing's warfare paradigm which impacted its effectiveness.

In the warfare doctrine of the day the aeroplane was a means of communications.⁶² The linking of the wireless and the aeroplane made possible a new dimension of mobility and a degree of command and control never before possible; truly a revolutionary event. The British actively used the aeroplane to provide their firing batteries with control and direction after October 1914. In 1917 the struggle for air supremacy had already begun in Europe, and tactical and artillery reconnaissance became established practice.⁶³ Carroll

Glines, author of the *Compact History of The United States Air Force*, develops the position that at the outbreak of the war the U.S. had virtually no military aviation: either planes, pilots, instructors or, more importantly, practical experience to support its overall war effort. In April 1917 the Aviation Section owned fewer than 300 training planes and 35 officers were rated as pilots. No airplane had a machine gun, nor had America ever trained an aviator for combat. In fact the U.S. Army did not know what type of training to provide radio and camera operators. Glines' statement, "America, shielding itself from the reality of events 3,000 miles away, had been outdistanced by the belligerents in the science of aviation," is an consequence of a constrained Signal Corps' developing its aviation responsibility in a manner inconsistent with the character of warfare it faced in Europe.⁶⁴

The Consequences of Building The Signal Corps based on the Wrong Paradigm

In his Report To the Secretary of War, The Office of the Chief Signal Officer acknowledged the AEF Signal Corps was "woefully lacking" organizationally, technologically and doctrinally in comparison with all belligerent powers. "Neither equipment nor organization had been materially changed as a result of the war which was on going in Europe, nor had methods of training been adapted to conditions which existed overseas."⁶⁵ America's Army "had no organized units, that could be sent overseas prepared for war."⁶⁶ The Signal Corps' ability to procure and train a technical force to meet the initial mobilization requirements, and then sustain that force, was marginally effective. The Office of the Chief Signal Officer initiated every action that could have reasonably been expected. However, conflicting priorities existed that had significant impact on sustaining required strength levels of the Corps; the primary contributing forces being the industrial

base manpower requirements, and those of the combat arms. Only through the passage of the Selective Service Law and an increased output from the training base, both military and civilian, were strength quotas met. Even given these improvements the possibility that the Signal Corps could have met the 90,000 strength projection in 1919 is questionable.⁶⁷

While the Signal Corps' electronic laboratories made significant achievements during the course of the war, their secret of its success was not internal. To combat the enemy's achievements the AEF possessed limited tactical communication resources, therefore it became dependent upon the French and British. The Allied Armies, acting as a buffer, stood between the U.S. and the enemy as the AEF organized and equipped itself. Although eventually industry responded, demand exceeded supply. During the summer of 1918, it became necessary to press the French into increasing the supply of radio material because the American industrial base could not respond in the time required.⁶⁸ The Signal Corps was "obliged" to rely solely upon the French for poles and crossarms, dry batteries, buzzerphones, switchboards, and radio and earth telegraphy sets. Without these assets the communications mission for the American Expeditionary Forces could not have been fulfilled.

. . . our experience taught one great lesson that, while it stood out so prominently to the general headquarters, it is likely soon to be forgotten. That lesson is: the unprepared nation is helpless in a great war unless it can depend upon other nations to shield it while it prepares. Every scrap of the history of the AEF bears this lesson. . .⁶⁹

The armistice found the United States nearing the completion of a radio development program especially designed to meet Army requirements, but very little of this equipment ever reached the field.

Operations on the western front revealed a war of position and the unlikelihood of fighting a war of movement. However, General Pershing maintained a "determined insistence" to the offensive and encouraged a warfare based on movement. Adoption of British publications as our model for tactical communications' doctrine provided a strong foundation to build upon. This doctrine allowed sufficient flexibility to accommodate the judgment of the signal soldier and his leadership. It also gave thorough guidance for decentralized application and execution. But, most importantly, the leadership of the Corps recognized the need for a doctrine that adequately met the requirements of position and movement warfare. As the aeroplane's role increased, and the effectiveness of the infantry's offensive was tied to its ability to coordinate indirect artillery fires, the Signal Corps responded. Within its constraints it sought to overlay the European paradigm on its own.

Major General George O. Squier, Chief Signal Officer during the period 1917-1923, stated that the efficiency of the WWI Signal Corps should be measured against its performance under the actual test of battle and "in the military areas, which supply and maintain the combatant troops."⁷⁰ Realizing their utter unpreparedness for the character of warfare they faced, the Signal Corps quickly and efficiently responded to each challenge. Representing less than four percent of the Army's total strength, it influenced every combat action. To realize that one may simply look at how it responded during the Second Battle of the Marne⁷¹ and the Meuse-Argonne Offensive.⁷² Historical research reveals it was not a perfect Signal Corps, but one struggling by the strength of the individual soldier to get the message through.

Such was the Signal Corps' entrance into World War I. Thrust into an immediate requirement for the provision of soldier technicians equipped with the most current technology, and implementation based on evolving doctrine, the Signal Corps found itself lacking as it built on the wrong paradigm. Technologically, organizationally and doctrinally it matured as it matured to the changing conditions of war, but at great cost of both men and material. The reluctance to shift paradigms is summed up in the historical record with reports of Allied observers who "despaired in the AEF's early battles when they found lines of dead American's mowed down in windrows like their French and British predecessors of 1914 and 1915."⁷³ Second only to the Infantry⁷⁴ the Signal Corps' casualty list contained 2,840 names.⁷⁵

SECTION III

THE SIGNAL CORPS INTO THE EARLY TWENTY-FIRST CENTURY

Yesterday and Tomorrow: A Compelling Argument to Remember

Once again the Signal Corps is facing unprecedeted challenges to emerge from a Revolution in Military Affairs towards a new paradigm. The Signal Corps of Force XXI faces the realities of remaining in a constant state of evolution while sustaining itself on the edge of revolutionary change. This being accomplished in a time when the Army is experiencing a serious affordability crisis in terms of force structure and resourcing. This has the Signal Corps traversing a path that must lend itself to organizational changes, adaptation of emerging technologies once it arrives on the battlefield, and the adoption and integration of untested doctrines. Again it is caught in the chaos of those in authority who while permitting a new paradigm to emerge, are simultaneously fashioning it into the existing paradigm. This is the pathway worn down by yesterday's signal soldiers.

The complexities of twenty-first century warfare by orders of magnitude are greater, but the essential elements remain the same as its historical predecessor, World War I. Raising, training and sustaining a technical force will be no less difficult especially if tailored to fit an existing versus emerging warfare paradigm. Neither will the employment of evolving doctrine based on our revolutionary changes in technology. The shaping of the battlefield by emerging technologies will require the same flexible response and innovative applications as demonstrated by yesterday's signal soldier. With information warfare as the dominant paradigm for the Army of the twenty-first century, maintaining

information and communication systems that transit the battlespace is paramount to achieve information dominance. Faced with this challenge are many players, but none as critical as the United States Army's Signal Corps. If the Army's Force XXI⁷⁶ is to be fully capable of executing information warfare across the operational continuum, the Signal Corps must be an enabler of battlefield information requirements at the strategic through tactical levels of war.

Raising and Training A Technical Force: A Similar Challenge

As obvious as it was to the Chief Signal Officer in 1917 that the accession of communications specialists required for the war would present a monumental challenge, so should it be to today's leadership. The United States relies upon mobilization⁷⁷ as an essential tenet of the national defense strategy. That mobilization strategy permitted America to raise a large Army to fight in World War I, but the challenges it confronted in manning the technical services like the Signal Corps were formidable. The recent downsizing of the force has translated into deep cuts in the Signal Corps. Highly qualified signal soldiers possessing years of experience and training accepted early outs in order to pursue alternative career opportunities at the expense of eroding the Army's technical base. At the same time accession rates continue to fall in a manner consistent with the sizing of the force; this translating into fewer soldiers being trained in state of the art information and communication technologies. Yet, the successful execution of two near simultaneous Major Regional Contingencies (MRC) will require substantial increases in current strength levels of communication/information specialists.

One should proceed with caution before believing a resource pool will be readily available to build overnight an operationally ready Signal Corps capable of responding to the Army's infinite desire for information and communication services. "Timely and accurate information has become the single most demanded commodity of modern warfare . . . data requirements have exploded."⁷⁸ With every aspect of the battlefield controlled by a software program, we are "being overwhelmed by the ever-increasing needs for software that are vastly outstripping the body of manpower available to produce and maintain software."⁷⁹ Seymour J. Deitchman, Vice President for Programs at the Institute for Defense Analysis, strengthens this argument by stating that the resource pool of personnel that can potentially handle sophisticated equipment must be enlarged. However, this translates into dollars for personnel and training. The alternative he offers is to slow the pace of technological adaptation of equipment so "less capable" personnel can operate the systems. This alternative means a less capable force.⁸⁰

If Desert Storm was the first information war, as some claim, then singularly important is the reality that the US communications infrastructure was inadequate for the way commanders intended to fight.⁸¹ This inadequacy centered around the lack of trained users of information and communications technology in the Army. "Training is the glue that holds the Army together."⁸² This is a truth that has remained constant throughout the 219 years the United States Army has served this nation. A trained force has always provided the edge for ensuring decisive victory. The words found in General Douglas MacArthur's *Report of the Secretary of War to the President 1933* serve to remind all generations of military professionals that "in no other profession are the penalties for employing untrained personnel so appalling or so irrevocable as in the military."⁸³

Unfortunately training today is insufficient to support the corresponding Revolution in Military Affairs happening in the information arena.

"An expert system requires an expert user," says Michael R. Macedonia in his article "Information Technology in Desert Storm." He states that the quality of the operators' computer knowledge , their understanding of its application and their ability to process data was woefully lacking.⁸⁴ This parallels the experience of the World War I commander in the field regarding the radio. In spite of the availability of the radio, its newness prevented its maximum employment because neither its operators nor their leaders understood how it worked. But more significant is the fact they failed to realize its potential for revolutionizing how they controlled and fought the war.⁸⁵

"Technological expertise should be of particular concern to the Army . . . if an RMA is, in fact, underway . . . and the Army intends to play a major role, it must develop a long-term program for cultivating technological expertise among all its officers rather than simply a tiny cadre."⁸⁶ Colonel Thomas A. Lenox in his paper, "The Army's Pipeline For Technological Officers: Is It Broken?" states that "most Americans are improperly educated to function in the everyday world of the next century, and that only a small part of society is being prepared for careers in technical fields."⁸⁷ In his examination of the Army's precommissioning program, his conclusions were "foreboding and sobering." He concludes inconsistent application of the personnel acquisition system is resulting in "the overstatement of the Army's actual supply of "high technology" officers" especially in the combat support and service support branches. Furthermore, with the continuous erosion of the general technological education received by Americans in its primary schools, secondary schools and universities, the Army is losing any foundation upon which to build

its technological education programs.⁸⁸ These are the words of the National Commission on Excellence in Education:

Our nation is at risk. Our once unchallenged preeminence in commerce, industry, science and technological innovation is being overtaken by competitors throughout the world. . . . The educational foundations of our society are presently being eroded by a rising tide of mediocrity that threatens our very future as a Nation and a people. . . . If an unfriendly foreign power had attempted to impose on America the mediocre educational performance that exists today, we might well have viewed it as an act of war. . . . We have, in effect, been committing an act of unthinking, unilateral educational disarmament.⁸⁹

Those who would believe America possesses a human resource base that can overnight become warriors capable of fighting information revolution-based knowledge warfare⁹⁰ need to rethink their position. Listen to the words of Edward M. Coffman as he speaks of the American Army in peacetime: "Many Americans may not remember their history, but they are concerned about large budgets, and they want a smaller Army. . . . Technology, however, will never permit a return to the belief that defense is simply a matter of the sturdy yeoman farmer gripping his musket and marching off for a few weeks, or perhaps months, to solve the military problem."⁹¹ It will take more than the six months we had to build the force in Desert Storm to raise a technical force capable of fighting and winning tomorrow's information war. Therefore, the Signal Corps needs a training philosophy and methodology that is applicable to the current environment and that will bring us into the paradigm of information warfare.

Acquisition And Assimilation Of Emerging Technology: The Same Challenge

Martin Van Crevell in *Technology and War* argues that not only is every part of war touched by technology, so does every part of technology affect war. He submits that

communications shape the face of war as much as weapons and weapon systems. It may in fact help constitute the infrastructure of war that contributes to dictating the concept of battle.⁹² He goes one step further in his book, *Technology And War From 2000 B.C. To The Present*, when he states, "Not only the conduct of war, but the very framework our brains employ in order to think about it, are partly conditioned by the technical instruments at our disposal."⁹³

Despite all the resources thrown at America's mighty industrial machinery in 1917, it could not respond in time to equip and sustain the signal soldiers of WWI with current technology when they needed it. The reality of then and today centers on the fact that technology outpaces the acquisition cycle. The downsizing of the defense structure is manifesting itself in reduction of R&D efforts and reliance on incremental changes to current technology that are affordable in today's defense budget. The lesson that "only when technology is developed , manufactured and put to use does it make a difference" has not changed.⁹⁴ The importance of possessing an industrial base capable of responding to these technological innovations on the battlefield by providing a momentous variety of equipment and repair parts is no different. General John A. Wickham, Jr., USA (Ret.) reminds readers of the *Signal Journal*, "the uncertain future we face calls for armed forces and a supporting industrial base. . . ."⁹⁵ Although recognized as the world's leading industrial power, America accomplished little prior to April 1917 to prepare for the transition of civilian industry to wartime production. America discovered planning and retooling required one year, followed by the reality that production levels were inadequate for almost another year.⁹⁶ Faced with the immediate crisis of equipping the Signal Corps, its Anglo-French allies became the Signal Corps source of supply.

In his annual report to the President and Congress in 1992, Defense Secretary Richard B. Cheney told Congress that "maintaining the technological superiority of our forces will require continuing investments in research and development to produce state-of-the-art capabilities."⁹⁷ Stating that national defense demands that we plan now for future needs, he cited the fact that the systems used in the Gulf War were available only because of research decisions made 20 to 30 years previously. In his report he pinpointed communications as an especially critical technology area. But less one conclude the Signal Corps in specific, or the Army in general, was prepared to satisfy the warfighter in the field, it is important to examine the Gulf War in light of some facts.

America's defense establishment gained a glimpse of future information wars during the conduct of the Gulf War. Field commanders and the signal community quickly realized the consequences of military technology not keeping pace with the computer revolution. The Signal Corps' reliance on antiquated, in terms of existing 1990's technology, communications networks to satisfy requirements no longer met the warfighter's needs for information dissemination and collection. Untested commercial systems adapted for use fulfilled the immediate needs. Filling the gap were personal computers with modems that sent enormous amounts of record traffic via commercial phone lines more efficiently and effectively than the Signal Corps message system. Facsimile machines became the primary means of transmitting graphics, such as charts and maps, to tactical units.

"Desert Storm demonstrated that communications needs to keep pace with the mobile battle and that continuous movement can enhance survivability."⁹⁸ More importantly, for the Army to retain the decisive edge on future battlefields "it must maintain overmatching

technological capabilities through continuous modernization.⁹⁹ General Sullivan, in discussing the needs of tomorrow's information age army, considers an acquisition process capable of keeping a "pace closer to the rate of technological innovation and production" of fundamental importance.¹⁰⁰

Mixed in with the development of a new set of conceptual, technical and organizational skills came an explosion of technological innovations. The technology of World War I was "immeasurably more complicated than that of any previous war."¹⁰¹ The same can be said of the next war. Technological advancement is made possible by maintaining a stable manufacturing and R&D capability in the military sector. This translates into planning and working on the next generation of technology at the same time a generation of military equipment is being procured and distributed.¹⁰²

But reality is that recent studies conducted over the last decade continue to support the conclusions that America possesses a declining industrial base that will not meet its challenges "to support the mobilization, deployment, sustainment, and expansion of military forces during wartime."¹⁰³ Its aging facilities, shortages in critical material and labor, increasing lead times and foreign source dependencies point to an industrial base inadequate to serve the nation in the next war. As General (Ret.) Wickham reminds us, "let's not destroy our industrial capability by unwise reforms. As we downsize, it will be important to ensure balance between maintaining a vigorous production base and developing technology for future military equipment."¹⁰⁴

Information Warfare: The call for a Renaissance in Doctrinal Thinking

Information warfare is redefining the battlespace and the vertical continuum of war. No longer does a clear line exist between the operational, strategic and tactical levels of war. "In order to complete the transition to third wave knowledge warfare from second wave maneuver warfare, future doctrine must take into account the criticality of information as a key element of combat power and must address the concept of information dominance."¹⁰⁵ Unfortunately, as argued in Section One, the Signal Corps appears not to be dealing with the ambiguities and complexities presented by the RMA.

It is generally agreed that doctrine is the accepted body of ideas governing the conduct of war and operations other than war. It is the condensed expression of the Army's fundamental approach to fighting that "permeates the entire organizational structure of the Army and sets the direction for modernization and the standard for . . . training."¹⁰⁶ Doctrine is designed to accommodate major technological opportunities, that once embraced provide the warrior with battlespace advantage. It must be relevant to its environment, sufficiently broad and forward looking to adapt to change, and understandable to its implementer. If FM-100 is correct in the fact doctrine drives change in the Army, then it is imperative that the Army have it right.¹⁰⁷

If the Revolution in Military Affairs is to change the way Signal Corps executes its roles and mission, there must be a framework of viable doctrine built that guides the technology, acquisition and force development efforts. The US Army and Training Command is leading the way in defining information warfare doctrine, but whether it is focused towards a new doctrinal paradigm of knowledge-based operations enabled by information age technology is questionable.¹⁰⁸ The AEF in failing to construct appropriate

doctrine consistent with the character of warfare it faced, contributed to the inability of emerging technologies to be integrated as a decisive tool on the battlefield by the Signal Corps. Instead of adapting our doctrine to the developing information age it is time to rewrite not reward it. The Army's senior leadership's strategy is in place to do just that but it is still limited by its partnership with an Army tied to its maneuver based paradigm.¹⁰⁹ General Pershing should remind them of the consequences of a leader who so tied to the existing paradigm cannot see a new paradigm emerging; of senior leaders preoccupied with coalition politics.

Information warfare is the call for a renaissance in doctrinal thinking that will redefine communications support as we know it. Lest the experience of World War I be revisited, doctrine must be an interactive process between itself and the technologies used in the battlespace. Perhaps now is the Signal Corps' opportunity to become the architects of this new doctrine and to base it on the correct warfare paradigm.

SECTION IV

IN THE FINAL ANALYSIS . . .

For the present, I believe that the Army is capable of winning decisively if we continue to access quality people, develop realistic and challenging training and promulgate solid and innovative doctrine for our current mix of forces. However, victory never comes cheaply - it is bought with the blood of our soldiers.¹¹⁰

If information is the currency of tomorrow's battlefield, the soldiers entrusted with the technical skills to employ it will become a precious resource. "Even in the information age, the human heart and will govern action in war. . . . Courage, selflessness, comradeship and leadership are not diminished by changing technology, organizations or concepts."¹¹¹ Today's Signal soldier, like yesterday's, will encounter unprecedented challenges which will test their tactical and technical abilities. They can be successful, "but only if they are equipped with modern technology, are well-trained and led, use up-to-date doctrine and are organizations that fit their technology and doctrine."¹¹² "Technologies may drive the RMA, but people . . . will carry it out."¹¹³

For the world is still a dangerous place. Only the dead have seen the end of the conflict. And though yesterday's challenges are behind us, tomorrow's are being born.¹¹⁴

I ask the Signal Corps' leadership if we are properly responding to our Revolution in Military Affairs? This study argued the transformation we face in the nature and conduct of future wars is no less fundamental than that of World War I. Social, technological, and political influences served to stimulate a revolutionary change in our nature of warfare. These same influences are fashioning today's warfare into an information revolution-based

knowledge warfare. The Army of Force XXI offers us a classic example of institutions in the midst of a Revolution in Military Affairs that is choosing not to shift its paradigm.

The Army Signal Corps must foster a vision that guides itself on a path away from this cycle. Today it must learn how to navigate through a minefield of constraints similar to those experienced by its World War I predecessor. The ambiguity of the future demands that the Army possess the highest probability of success. The Signal Corps must be willing to penetrate into the eye of the information revolution and lead the way. We must remember that revolutionary change requires a new paradigm.

To the extent we can learn from the past, we are better prepared to do what those before us could not-break the mold and build the right Army [Signal Corps].¹¹⁵

ENDNOTES

¹John R. Galvin, "Uncomfortable Wars: Toward A New Paradigm," *Parameters*, Vol.XVI, No. 4, p.2.

²Michael J. Mazarr, "The Revolution In Military Affairs: A Framework for Defense Planning," (Carlisle Barracks, PA: Strategic Studies Institute, June 1,1994).

³Department of the Army, *Army Focus 94, Force XXI, America's Army In The 21st Century* (Washington, D.C.: US Army Publication and Printing Command, 1994), p. 22.

⁴Richard J. Dunn III, *From Gettysburg to the Gulf and Beyond: Coping with Revolutionary Technological Change in Land Warfare* (Washington, D.C.: National Defense University, Institute for National Strategic Studies, 1992), pp. 5-6.

⁵Dana M. Cound, *A Leader's Journey To Quality* (New York: Marcel Dekker, Inc., 1984), p.7.

⁶Thomas S. Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1970), p.176.

⁷Ibid., p.109.

⁸Ibid., p.84-85.

⁹Ibid., p.78.

¹⁰Colonel Harry K. Lesser, Jr., USA, "The Revolution In Military Affairs And Its Effect On the Future Army," (Newport, RI: Naval War College, June 1994).

¹¹Could, p. 11.

¹²Ibid, p.10.

¹³Baron de Antoine Henri Jomini, *The Art of War* (Westport, CT: Greenwood Press, 1971), p.298.

¹⁴David B. Hawke, "Military History and the Modern Soldier," *Military Review*, Vol. LXXIII, No.7 (January 1993), p.66.

¹⁵Kuhn, p.90.

¹⁶Kuhn., p.111.

¹⁷Chief of Signal, United States Army Signal Center, *Signal 2000: Signal Support For Force Projection Operations* (Fort Gordon, Georgia: 1992), p. 1-1 thru 4-3. The language nor intent of that document has changed to date.

¹⁸This process encompasses doctrine, training, leader development, organization, material and soldiers.

¹⁹Chief of Signal, *Signal The Voice Of Command* (USASC&FG; US Army Printing Press, 1993), p. 10.

²⁰ Dunn , pp. 5-6. Harry K. Lesser, Jr. also cites Dunn in his paper, "The Revolution In Military Affairs And Its Effect On The Future Army."

²¹George R. Thompson, "U.S.Army Radiotelephone in World War I," *Signal*, (June 1962), p.81. When the U.S. Army went to war in 1917, the Signal Corps was providing only two radio types for field use. Both were large high-powered quenched sparks transmitters. These were so called Pack radio sets (SRC-49), which could be broken down into several components for transport by two or three Army mules, and a still larger Motor Truck, or Tractor, Set (SRC-50).

²²Dulany Terrett, *The Signal Corps: The Emergency* (Washington, D.C.: Government Printing Office, 1956), pp. 16-19.

²³Excerpts from *Report by Major General John J. Pershing of the Punitive Expedition*, dated October 10,1916, pp. 43-44. (Typewritten).

²⁴War Department, "Report of The Chief Signal Officer," *War Department Annual Reports, 1917* , 3 vols. (Washington, D.C.: Government Printing Office, 1918), I, p. 837.

²⁵John J. Pershing, *Excerpts from Report by Major General John J. Pershing of the Punitive Expedition dated 10 October 1916*, p. 44.

²⁶War Department, "Report of The Chief Signal Officer," *War Department Annual Reports, 1917*, 3 vols. (Washington D.C.: Government Printing Office, 1918), I, p.837.

²⁷J.G.Harbord, "Radio In War," *The Signal Corps Bulletin* 77 (March-April 1934), p.31.

²⁸David L. Woods, *A History of Tactical Communication Techniques* (Orlando: Martin Company, Martin-Marietta Corporation, 1965), p.124.

²⁹George P. Scriven, *The Service Of Information United States Army* (Washington, D.C.: Government Printing Office, 1915), pp. 37-38.

³⁰Edward M. Coffman, "The American Army In Peacetime," *Military Review*, Vol. LXXII, No. 3 (March 1992), p.56-58.

³¹T. Harry Williams, *The History of American Wars*. (New York: Alfred A. Knopf,Inc., 1981), pp. 352-389.

³²Ibid., p. 380.

³³Harbord, pp. 27-28.

³⁴Allan R. Miller and Peter Maslowski, *For The Common Defense A Military History of the United States of America* (New York: The Free Press, 1984), p.349.

³⁵James W. Rainey, "Ambivalent Warfare: The Tactical Doctrine of The AEF in World War I," *Parameters*, September (1983), p. 91.

³⁶Ibid.

³⁷Ibid, pp. 91-92. Rainey uses a primary source to establish his argument: John J. Pershing, *My Experiences in the World War* (New York: Stokes, 1931), I, 150. He also

cites: Frank E. Vandiver, *Black Jack: The Life and Times of John J. Pershing* (College Station: Texas A&M Univ. Press, 1977), II, 772; Memorandum, French G.H.Q., Armies of the North and North East, 1 May 1918, no subject, National Archives, Records Group 120, Entry 22, Folder 265; Memorandum, G-5 to Chief of Staff, G.H.Q., AEF, 4 July 1918, National Archives, Records Group 120, Entry 268, Folder 695-B.

³⁸T. Harry Williams, *The History Of America Wars* (New York: Alfred A. Knopf, Inc., 1981), pp.352-389.

³⁹David J. Marshall, *The Story of the U.S.Army Signal Corps* (New York: Franklin Watts, Inc., 1965), p. 145.

⁴⁰Ibid., p. 225.

⁴¹War Department, Office of the Chief Signal Officer, *Report Of the Chief Signal Officer, To The Secretary Of War 1919* (Washington, D.C.: Government Printing Office, 1919), pp. 6-7.

⁴²Williams, p. 380.

⁴³Terrett, pp. 16-19.

⁴⁴Edwin R. Petzing, "Development Of Radio In The United States Army," *The Signal Corps Bulletin*, March (1928), p.36.

⁴⁵Committee of Imperial Defense of Great Britain, *Military Operation, France and Belgium, 1916* (London: The Macmillian Company, 1933), pp. 68-71.

⁴⁶Petzing, p.36.

⁴⁷Terrett, p.16.

⁴⁸War Department, Office of the Chief Signal Officer, *Report of the Chief Signal Officer To The Secretary Of War 1919* (Washington, D.C.: Government Printing Office, 1919), pp. 23-25. At the signing of the armistice the strength of the Signal corps was 2,712 officers and 53,277 men. They were organized into 56 field signal battalions, 33 telegraph battalions, 12 depot battalions, 6 training battalions and 40 service companies.

⁴⁹Terrett, p.20.

⁵⁰J.H.Hinemon, "Wartime Selection, Training and Placement of Signal Corps Personnel," *The Signal Corps Bulletin*, September-October (1935), pp.1-13.

⁵¹Ibid., p.2.

⁵²Alfred E. Larabee, "The Signal Corps and Signal Communication," *The Signal Corps Bulletin*, September (1925), p.32.

⁵³James B. Allison, "Some Thoughts On Signal Communications In The Theater Of Operations," *The Signal Corps Bulletin*, March-April (1936), pp.1-2.

⁵⁴ Woods, p. 225.

⁵⁵Historical Division, Department of the Army, *Reports of Commander-In-Chief, A.E.F., Staff Section and Services* (Washington, D.C.: Government Printing Office, 1948), 15, p.102.

⁵⁶Schniewindt, General, "Signal Communications Between The Headquarters Staff During The Warfare Of Movement in 1914," *The Signal Corps Bulletin*, September-October (1933), p.1.

⁵⁷Rainey, pp. 132-136.

⁵⁸Author Unknown, "Homing Pigeons Used By the Signal Corps During The World War," *The Signal Corps Bulletin*, June (1925), pp. 38-39.

⁵⁹Ibid.,p.20.

⁶⁰R.B.Moran, "Powers and Limitations of Radio Communications Within a Modern Field Army," *The Signal Corps Bulletin*, July-August (1936), p.35.

⁶¹War Department, War Plans Division, *Inter-Communication in the Field* (1918), pp. 9-10.

⁶²Woods, p.241.

⁶³Historical Section, The Army War College, *The Signal Corps and Air Service: A Study Of Their Expansion In The United States 1917-1918* (Washington, D.C.: Government Printing Office, 1922), p.34.

⁶⁴Carroll V. Glines, *The Compact History Of The United States Air Force* (New York and London: Hawthorn Books, Inc., 1965), pp. 72-73.

⁶⁵War Department, Office of the Chief Signal Officer, *Report of the Chief Signal Officer To The Secretary Of War 1919* (Washington, D. C.: Government Printing Office, 1919),p. 11.

⁶⁶John J. Pershing, *Final Report Of Gen. John J. Pershing, Commander-In-Chief American Expeditionary Forces* (Washington, D.C.: Government Printing Office, [1920]), p. 5.

⁶⁷Allison, p. 5-6.

⁶⁸American Expeditionary Forces, *Report Of The Commanding General S.O.S. Commander In Chief*, 3 vols. (France: American Expeditionary Forces, 1919), vol. 3: *History Of the Supply Division, Signal Corps American Expeditionary Forces*.

⁶⁹Historical Division, Department of the Army, *U. S. Army in the World War. 1917-1919*, 16 vols. (Washington, D.C.: Government Printing Office, 1948), vol. 14: *Reports of Commander-In-Chief, A.E.F., Staff Section and Services*, p. 60.

⁷⁰Terrett, p. 11.

⁷¹The General Service Schools, The General Staff School 1921-1922, *Campaign of 1918 Americans At Second Battle Of the Marne*, "Special Report Operations of the Third

Division, 15-31 July, 1918. Second Battle of the Marne," (Fort Leavenworth, Kansas: The General Service Schools Press, 1922).

⁷²John H. Gardner, "Signal Communication In A Battalion Of Field Artillery During The Meuse-Argonne Offensive," *The Signal Corps Bulletin* 54, May-June (1930) clearly supports this conclusion.

⁷³Millett and Maslowski, p.349.

⁷⁴Second only to the Infantry if the Signal Corps battle casualty figures include Aviation losses during the period Aviation was an integral part of the Signal Corps. From Leonard P. Ayers, *The War With Germany, a Statistical Summary* (Washington: GPO, 1919).

⁷⁵War Department, Office of the Chief Signal Officer, *Report Of The Chief Signal Officer To the Secretary Of War 1919* (Washington, D.C.: Government Printing Office, 1919), p. 524. Statistics reflect 179 killed in action, 112 died of wounds received in action, and ten others died of gas received in action. The remainder of the list included 458 severely wounded and 707 slightly wounded in action, 41 severely gassed, 350 slightly gassed and 165 gassed to an undetermined degree. The remaining 27 died of disease or were accidentally killed.

⁷⁶Department of the Army, *Army Focus 94, Force XXI, America's Army In The 21st Century* (Washington, D.C.: US Army Publication and Printing Command, 1994), p. 3. The Army has built a strong and enduring bridge to the future. This focus on the future is captured in the term "Force XXI-America's Army for the 21st Century."

⁷⁷Mike Rigsby, "US Army Material Requirements Methods for Industrial Preparedness Planning," (Newport, Rhode Island: Naval War College, February 1989), pp.5-6. "Mobilization is defined as the act of preparing for war . . . through assembling and organizing the national resources. Mobilization is an extremely complex process involving the resources of the entire nation . . . and will likely be the linchpin in our survival as a nation."

⁷⁸*Army Focus 94, Force XXI, America's Army In The 21st Century*, p.22.

⁷⁹Admiral Bobby R. Inman, *Technology and Strategy*, Reprinted from *Proceedings*, Vol. 110, Sea Link Supplement (December 19840), p.8.

⁸⁰Seymour J. Deitchman, "Weapons, Platforms, and The New Armed Services," Air War College-Associated Studies, Vol. 1, Military Environment And Policy Formulation, Chapter 19, Military Technology.

⁸¹Michael R. Macedonia, "Information Technology in Desert Storm," *Military Review*, Vol. LXXII, No.10 (October 1992), pp.35-36.

⁸²Department of the Army, Office of the Chief of Staff, *United States Army Posture Statement FY95, Challenges and Opportunities* (Washington, D.C.: US Army Publication and Printing Command, 1994), p. 89.

⁸³War Department, Secretary of War, *Report of the Secretary of War to the President 1933*, (Washington, D.C.: Government Printing Office, 1919), p. x.

⁸⁴Ibid, p. 39.

⁸⁵It is not my intent to misrepresent the effectiveness of information technologies employed during the Gulf War. The effective and efficient uses of such technology is well documented.

⁸⁶Steven Metz and James Kievit, "The Revolution In Military Affairs And Conflicts Short Of War" (Army War College: Strategic Studies Institute, 1994), p. 31.

⁸⁷Thomas A. Lenox, "The Army's Pipeline For Technological Officers: Is It Broken?" An Individual Study Project (Carlisle Barracks, Pennsylvania: U.S. Army War College, 1993), p. i.

⁸⁸Ibid, pp.43-45.

⁸⁹National Commission on Excellence in Education, *A Nation At Risk, Report of the National Commission on Excellence in Education* (Washington, D.C.: U.S. Government Printing Office, April 1983), p.1.

⁹⁰It appears that information based warfare may be interchangeable with knowledge based warfare. Regardless, the central thesis of this war paradigm is the ability to collect, analyze, disseminate and act of battlespace information as the dominant factor. It exploits information as a combat or force multiplier.

⁹¹Edward M. Coffman, "The American Army in Peacetime," *Military Review*, Vol.LXXII, No.3 (March 1992), p. 59.

⁹²Martin Van Crevell, *Technology and War* (New York: The Free Press, 1989), p.311.

⁹³Martin Van Crevell, *Technology And War From 2000 B.C. To The Present* (New York: Th Free Press, 1989), p. 247.

⁹⁴Jonathan Shimshoni, "Technology, Military Advantage, and World War I: A Case for Military Entrepreneurship. *International Security*, Vol. 15, No. 3, (Winter 1990), p.193.

⁹⁵John A. Wickham, Jr., "Strong, Responsive Defense Must Be Preserve as Budgets Decline," *Signal* (September, 1992), p.19.

⁹⁶Larry H. Addington, *The Patterns Of War Since The Eighteenth Century* (Bloomington: Indiana University Press, 1984), p.148.

⁹⁷AFCEA, "Pentagon Picks Technology For New Weapon Systems," *Signal* (June 1992), p.51.

⁹⁸Paul Sass and Ingrid Eldridge, "Army Demonstrates Wideband On-the -Move Communications for Digitized Battlefields," *Signal* (March 1994), p.54.

⁹⁹Gordon R. Sullivan, "Moving into the 21st Century: America's Army and Modernization," *Military Review*, Vol. LXIII, No.7 (July 1993), p.4.

¹⁰⁰Sass, p.57.

¹⁰¹Bernard and Fawn M. Brodie, *From Crossbow to H-Bomb* (Bloomington: Indiana University Press, 1973), p.173.

¹⁰²Seymour J. Deitchman, "Weapons, Platforms, and The New Armed Services," Air War College-Associated Studies, Vol. 1, Military Environment And Policy Formulation, Chapter 19, Military Technology.

¹⁰³Rigsby, p.6.

¹⁰⁴General John A. Wickham, Jr., USA (Ret.), "Strong, Responsive Defense Must Be Preserved as Budget Declines," *Signal*, September 1992, p.19.

¹⁰⁵Ibid, p.18.

¹⁰⁶Department of the Army, *FM 100-5 Operations* (Washington D.C.: Government Printing Office, June 1993), p. 1-1.

¹⁰⁷Department of the Army, *Army Focus 94, Force XXI, America's Army In The 21st Century* (Washington, D.C.: US Army Publication and Printing Command, 1994), pp. 18-19.

¹⁰⁸Ibid, p.18.

¹⁰⁹Lesser, "That technology is detailed in the *Army Modernization Plan*, the *Army Enterprise Strategy*, and the *Army Science and Technology Master Plan* . . . From the Knowledge Warfare perspective, the *Army Enterprise Strategy* is the most important of the three modernization documents because it describes what the Army must do to win the information warThe *Army Enterprise Strategy* focuses on identifying, supplying, and implementing information and other command, control, communications, and computer technologies needed to support the Army through ten principles." They are focus on the warfighter, ensure joint interoperability, digitize the battlefield, modernize power projection platforms, optimize the information technology environment, implement multi-level security, ensure spectrum supremacy, acquire integrated systems using commercial technology and exploit modeling and simulation. "The *Army Enterprise Strategy* provides a strategy for the army to exploit current and future information technologies required to implement Knowledge Warfare doctrine.

¹¹⁰Sullivan, "Moving into the 21st Century: America's Army and Modernization," p.3.

¹¹¹Sullivan, "War in the Information Age," p.58.

¹¹²Sullivan, "War in the Information Age, p.57.

¹¹³Mazarr, p.29.

¹¹⁴George Bush, "State of the Union Address," (1992): To the Congress and people of the United States.

¹¹⁵David F. Melcher and John C. Siemer, "How To Build the Wrong Army," *Military Review*, Vol. LXXII, No. 9 (September 1992), p. 76.

BIBLIOGRAPHY

- Armed Forces Communications-Electronics Association. "Pentagon Picks Technology For New Weapon Systems." *Signal* (June 1993): 8.
- Allison, James B., MG, U.S. Army. "Some Thoughts on Signal Communications in the Theater of Operations." *The Signal Corps Bulletin* 89 (March-April 1936): 1-10
- Brodie, Bernard and Fawn M., *From Crossbow to H-Bomb*. Bloomingdale, Indiana: Indiana University Press, 1973.
- Builder, Carl H. *The Icarus Syndrome*. New Brunswick and London: Transaction Publishers, 1994.
- Bush, George. "State of the Union Address." 1992. To the Congress and people of The United States.
- Chief of Signal, United States Army Signal Center. *Signal: The Voice of Command*. Fort Gordon, Georgia: US Army Printing Press, 1993.
- Classification Division, Adjutant General of the Army. *Personnel Specifications, Signal Corps: Field Signal Battalion, Telegraph Battalion, Pigeon Company*. [December 1918].
- Coffman, Edward M., "The American Army in Peacetime." *Military Review* (March 1992): 49-59.
- Committee of Imperial Defense of Great Britain. *Military Operation, France and Belgium, 1916*. London: The Macmillan Company, 1933.
- Cound, Dana M. *A Leader's Journey To Quality*. New York: Marcel Dekker, Inc., 1984.
- Cruttwell, C.R.M.F. *A History Of the Great War 1914-1918* .2nd ed. London Toronto Sydney New York: Granada Publishing Limited, 1936.
- Deitchman, Seymour J., "Weapons, Platforms, and The New Armed Services." Air War College Associate Studies, Vol. 1, *Military Environment And Policy Formulation*, Chapter 19, Military Technology.
- Dubik, James M. "Military Force: Preparing for the Future." *Military Review* (March 1992): 77-83.

- Dunn, Richard J., III. *From Gettysburg to the Gulf and Beyond: Coping with Revolutionary Technological Change in Land Warfare*. Washington, D.C.: National Defense University, Institute for national Strategic Studies, 1992.
- Galvin, John R. "Uncomfortable Wars: Toward A New Paradigm." *Parameters* (Vol.XVI, No.4.): 2-8.
- Gardner, John H., CPT, U.S.Army. "Signal Communications in a Battalion of Field Artillery During The Meuse-Argonne Offensive." *The Signal Corps Bulletin* 54 (May-June 1930): 33-44.
- General Headquarters American Expeditionary Forces. *Final Report Of Gen. John J. Pershing*. Washington, D.C.: Government Printing Office, 1920.
- General Headquarters, American Expeditionary Forces. *Report Of The Commanding General S.O.S. Commander In Chief*, 3 vols. France: AEF Printing Office, 1918. Vol 3: "History of the Supply Division, American Expeditionary Forces."
- Glines, Carroll V. *The Compact History Of The United States Air Force*. 3rd ed. New York and London: Hawthorn Books, Inc., 1965.
- Gourney, A.M., MAJ, U.S.Army. "Practical Means For Improving Liaison Between the Infantry and Artillery." *The Signal Corps Bulletin* 81 (November-December 1934): 36-46.
- Hawke, David B., "Military History and the Modern Soldier." *Military Review* (January 1993): 59-66.
- Headquarters Department of the Army. *United States Army Posture Statement FY95: Challenges And Opportunities*. Washington, D.C.: Government Printing Office, February 1994.
- Headquarters Department of the Army. *Army Focus 94 Force XXI*. Washington, D.C.: Government Printing Office, September 1994.
- Headquarters Department of the Army. *FM 24-1 Combat Communications*. Washington, D.C.: Government Printing Office, 1985.
- Headquarter Department of the Army. *FM 100-5 Operations*. Washington, D.C.: Government Printing Office, 1993.
- Headquarters U.S. Army Signal Center and Fort Gordon. *Signal 2000: Signal Support For Force Projection Operations*. Fort Gordon, Georgia: Government Printing Office, December 1992.

- Heller, Charles E. "Twenty-First Century Force: Federal Army And A Militia." Strategic Studies Institute Army War College, Carlisle Barracks, Pennsylvania, 14 June 1993.
- Hinemon, J.H.. "Wartime Selection, Training and Placement of Signal Corps Personnel," *The Signal Corps Bulletin* 54 (September-October 1935): 1-13.
- Historical Division, Department of the Army. *Reports of Commander-In-Chief, A.E.F., Staff Section and Services*. Washington, D.C.: Government Printing Office, 1948.
- Historical Division, Department of the Army. *Military United States Army In The World War 1917-1919*, 17 vols. Washington, D.C.: Government Printing Office, 1948.
- Historical Section, The Army War College. *The Signal Corps and Air Service: A Study Of Their Expansion In The United States 1917-1918*. Washington, D.C.: Government Printing Service, 1932.
- Howard, Michael, and Guilmartin, John F. Jr., "Two Historians In Technology And War." Strategic Studies Institute, U.S. Army War College Fifth Annual Conference on Strategy. Army War College, Carlisle Barracks, Pennsylvania, April 1994.
- Howard, Michael. "Military Science in an Age of Peace." *RUSI Journal of the Royal United Services Institute for Defence Studies* (March 1974): 3-10.
- Huntington, Samuel P. *The Soldier And The State: The Theory and Politics of Civil-Military Relations*. Cambridge, Massachusetts: The Belknap Press Of Harvard University Press, 1957.
- Inman, Bobby R., ADM, USN. "Technology and Strategy." Reprinted from *Proceedings* (December 1984): 8.
- Jomini, Baron de Antoine Henri. *The Art of War*. Westport, CT: Greenwood Press, 1971.
- Kohlmann, James P., MAJ, U.S.Army. "Winning The Information War: Challenges Of Providing Interoperable Information System Support To An Army-Led Joint Task Force." Master Thesis, Defense Technical Information Center, Cameron Station, Alexandria, Virginia, 3 June 1994.
- Kuhn, Thomas S. *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press, 1970.
- Larabee, Alfred E., MAJ, U.S.Army. "The Signal Corps and Signal Communications." *The Signal Corps Bulletin* 31 (September 1925): 28-38.

Latimer, John C., and Shaver David E. "Army Roles, Missions and Organizations for the Post Cold War." USAWC Military Studies Program Paper. U.S. Army War College. Carlisle, Pennsylvania, 15 April 1993.

Lenox, Thomas A., and Corn, V. B. "The Army's Pipeline For Technological Officers: Is It Broken?" USAWC Military Studies Program Paper. U.S. Army War College. Carlisle Barracks, Pennsylvania, 15 April 1993.

Lattin, Jay D. B., MAJ, U.S. Army. "A study of the Signal Communication of the Third American Division during the Defensive Phase of the Second Battle of the Marne, in July, 1918." Individual Research Study. The Command and General Staff School, Fort Leavenworth, Kansas, 3 May 1930.

Lesser, Harry K., Col, U.S. Army. "The Revolution In Military Affairs And Its Effect On the Future Army." Paper. Naval War College. Newport, Rhode Island, 24 June 1994.

Macedonia, Michael R. "Information Technology in Desert Storm." *Military Review* (October 1992): 34-41.

Mann, Edward, COL, USAF. "Desert Storm: The First Information War?" *Airpower* (Winter 1994): 4-14.

Marshall, Max L. *The Story of the United States Signal Corps*. New York: Franklin Watts, Inc., 1965.

Mazarr, Michael J., "The Revolution In Military Affairs: A Framework for Defense Planning." Strategic Studies Institute, Army War College, Carlisle Barracks, Pennsylvania, 10 June 1994.

Melcher, David F., and Siemer, John C., "How To BUILD the WRONG ARMY." *Military Review* (September 1992): 66-76.

Metz, Steven and Kievit, James. "The Revolution In Military Affairs And Conflict Short Of War." Strategic Studies Institute, Army War College, Carlisle Barracks, Pennsylvania, 25 July 1994.

Millett, Allan R., and Maslowski Peter. *For The Common Defense: A Military History of the United States of America*. New York: The Free Press, A Division of Macmillan, Inc., 1984.

Moran, R. B., MAJ, U.S. Army. "Powers And Limitations Of Radio Communi-cation Within A Modern Field Army." Individual Research Study, The Command and General Staff School, Fort Leavenworth, Kansas, 22 March 1935.

Moyer, William R., MAJ, U.S.Army. "The 1994 Louisiana Maneuvers: Is Back to The Future What Our Army Needs?" School of Advanced Military Studies, United States Army Command and General Staff College. Fort Leavenworth, Kansas, 28 May 1992.

National Commission on Excellence in Education. *A Nation At Risk Report of the National Commission on Excellence in Education*. Washington, D.C.: U.S. Government Printing Office, 1983.

"War Fighter's Impact Crucial In Altering Army's Azimuth." *Signal* (June 1993): 57-58.

Pershing, John J. *Final Report Of General John J. Pershing, Commander-In-Chief American Expeditionary Forces*. Washington, D.C.: Government Printing Office, [1920].

Pershing, John J. *My Experience In The World War*. 2 vols. New York: Frederick A. Stokes Company, 1931.

Petzing, Edwin R., CPT, U.S.Army. "Development of Radio in the United States Army." *The Signal Corps Bulletin* 42 (March 1928): 34-39.

Rainey, James W. "Ambivalent Warfare: The Tactical Doctrine of The AEF in World War I." *Parameters* (September 1983): 34-46.

Rainey, James W. "The Questionable Training of the AEF in World War I." *Parameters* (Winter 1992-1993): 89-103.

Reber, Samuel, COL, U.S. Army. "Signal Organization." *The Signal Corps Bulletin* 66 (May-June 1932): 35-40.

Rigsby, Mike, MAJ, U.S. Army. "US Army Material Requirements Methods For Industrial Preparedness Planning." Paper. Naval War College. Newport, Rhode Island, 10 April 1989.

Romjue, John L., Canedy Susan, and Chapman, Anne W. "Prepare The Army For War: A Historical Overview of the Army Training and Doctrine Command, 1973-1993," TRADOC Historical Study Series (1993): 52-69.

Sass, Paul and Eldridge, Ingrid. "Army Demonstrates Wideband On-the-Move Communications for Digitized Battlefields." *Signal* (March 1994): 4.

Schniewindt. "Signal Communications Between The Headquarters Staff During The Warfare Of Movement in 1914," *The Signal Corps Bulletin* (September-October 1933): 1.

Scriven, George P., BG, Chief Signal Officer Of The U.S.Army. *Circular No. 8, Office Of The Chief Signal Officer, 1915, The Service Of Information United States Army.* Washington, D.C.: Government Printing Office, 1922.

Shimshoni, Jonathan. "Technology, Military Advantage, and World War I." *International Security* (Winter 1992): 187-215.

Sullivan, Gordon R., and Dubik, James M. "War in the Information Age." *Military Review* (April 1994): 46-62.

Sullivan, Gordon R. "Moving into the 21st Century: America's Army and Modernization." *Military Review* (July 1993): 3-11.

Terrett, Dulany. *The Signal Corps: The Emergency.* Washington, D.C.: Government Printing Office, 1956.

The General Service Schools, The General Staff School 1921-1922. *Campaign Of 1918; Americans At The Second Battle Of The Marne.* Fort Leavenworth , Kansas: The General Service Schools Press, 1922.

The Infantry School. *Infantry In Battle.* Washington, D.C.: Infantry Journal Press, 1934.

Thies, Wallace J. "Continuity and Change in the New World Order." *Military Review* (June 1992): 39-48.

Third Division Historian. *History Of The Third Division United States Army In the World War For the Period December 1,1917, To January 1,1919.* Andernach-On-The Rhine, 1919.

Thompson, George Raynor; Harris, Dixie R.; Oakes, Pauline M.; and Terrett, Dulany. *The Signal Corps: The Test.* Washington, D.C.: Government Printing Office, 1957.

Truesdell, Karl, LTC, U.S.Army, Corps Signal Officer. "Signal Communications in the Meuse-Argonne Operations." Headquarters, Fifth Corps, American Expeditionary Forces. Lecture, 26 January 1919.

Van Crevell, Martin. *Technology and War.* New York: the Free Press, 1989.

Van Crevell, Martin. *Technology and War From 2000 B.C. \To The Present.* New York: The Fre Press, 1989.

War Department, Office of the Chief Signal Officer. *Report of the Chief Signal Officer 1919.* Washington, D.C.: Government Printing Office, [1919].

War Department, War Plans Division. *Inter-Communication in the Field*. Reprint ed., Washington, D.C.: Office of The Adjutant General, May 1918.

Wattles, William P., LTC, U.S.Army. "Wire Communications During The Meuse-Argonne Offensive." *The Signal Corps Bulletin* 56 (September- October 1930): 33-43.

Wickham, John A., Jr., Gen.(Ret.), USA, "Strong, Responsive Defense Must Be Preserved as Budgets Decline." *Signal* (September 1992): 19.

Williams, T. Harry. *The History Of American Wars*. New York: Alfred A. Knopf, Inc., 1981.

Woods, David L. *A History of Tactical Communications Techniques*. Orlando: Martin-Marietta Corporation, 1965.